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TITLE: Pore-scale Simulation of the Effects of Colloid Deposition on Fluid Flow and Solute Transport

ABSTRACT TEXT

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High-energy, synchrotron-based x-ray difference micro-tomography (XDMT) was used to resolve the pore structure of a granular porous medium, as well as colloidal deposits within the pore space, with near-micron-scale resolution. This detailed structural information was used to define internal boundary conditions for three-dimensional lattice Boltzmann (LB) simulations of the effects of the colloidal deposits on pore fluid flow. Colloid accumulation was observed to be highly heterogeneous at the pore scale. As colloids accumulated in the pore space, the mean tortuosity increased and the tortuosity distribution became multi-modal, indicating the development of macro-scale heterogeneity. These changes in the geometry of the pore space also greatly reduced the bulk permeability of the porous medium. In addition, a time-series of measurements was used to observe the dynamics of the deposition process in a single sample with successive colloid loading. The pore structure evolved to become increasingly complex over time, and local detachment of colloidal accumulation was found. LB simulations of solute transport indicated that these changes in pore structure produced anomalous diffusion behavior.